

PATENT
TS1268 (US)
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF APPEALS AND INTERFERENCES

In re application of)	
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JOZEF PETER PAUL HUIJSMANS)	Confirmation No.: 2824
GERARD JAN KRAAIJ)	
)	
Serial No. 10/542,154)	Group Art Unit: 1795
)	
Filed December 16, 2005)	Examiner: Ladan Mohaddes
)	
PROCESS FOR GENERATING ELECTRICITY)	February 7, 2011
AND CONCENTRATED CARBON DIOXIDE)	
_____)	

Sir:

APPEAL BRIEF

Applicants hereby submit this Appeal Brief in order to appeal the final rejection of claims 1-7 and 10-16 in the office action mailed September 9, 2010.

Please charge any fees that are necessary in connection with the filing of this brief to Shell Oil Company, Deposit Account No. 19-1800.

Real Party in Interest

The real party in interest is Shell Oil Company.

Related Appeals and Interferences

To the best of the undersigned's knowledge, there are no related appeals or interferences.

Status of the Claims

Claims 1-7 and 10-16 are pending in the application and were finally rejected in the office action mailed September 9, 2010. Claims 1-7 and 10-16 are on appeal.

Status of Amendments

No amendments to the claims have been filed since the Final Rejection.

Summary of Claimed Subject Matter

The invention as set forth in claim 1 is to a process for generating electricity and concentrated carbon dioxide. The process uses a molten carbonate fuel cell, the fuel cell comprising an electrolyte sandwiched between an anode and a cathode. This element is discussed in the specification at page 7, lines 29-31. The fuel cell further comprises an anode chamber and a cathode chamber. This element is discussed in the specification at page 7, line 32 and page 8, lines 8 and 9.

The process further comprises feeding a fuel gas to the anode chamber. This element is discussed in the specification at page 4, line 3 and page 7, line 32. The process further comprises feeding a cathode inlet gas comprising carbon dioxide and a molecular oxygen to the cathode chamber. This element is discussed in the specification at page 6, lines 14-16, page 5, lines 17 and 18 and page 3, lines 5 and 6. The process produces electricity, an anode off-gas and a cathode off-gas via anode and cathode reactions. This element is discussed in the specification at page 1, lines 2, page 7, lines 32 and 33 and page 8, line 8.

At least part of the anode off-gas is fed to a catalytic afterburner, wherein it is oxidized with an oxidant to obtain an oxidized anode off-gas. This element is discussed in the specification at page 5, lines 5 and 6 and page 3, lines 9-14.

The remainder of the anode off-gas is recycled to the anode chamber. This element is discussed in the specification at page 5, lines 6-8.

The oxidant used to oxidize the anode off-gas consists of part of the cathode off-gas and/or part of a molecular oxygen containing external oxidant stream. This element is discussed in the specification at page 3, lines 10 and 11. The external oxidant stream comprises at most 20% (v/v) nitrogen. This element is discussed in the specification at page 3, lines 7 and 8.

The oxidized anode off-gas is brought into heat-exchange contact with the remainder of the cathode off-gas and the remainder of the external oxidant stream to obtain a cooled anode off-gas and a heated mixture of cathode off-gas and external oxidant. This element is discussed in the specification at page 5, lines 23 and 28.

The cathode off-gas is cooled before it is brought in heat-exchange contact with the oxidized anode off-gas. This element is discussed in the specification at page 6, lines 6-8.

The cooled anode off-gas and the heated mixture of cathode off-gas and external oxidant are fed to the cathode chamber as cathode inlet gas. This element is discussed in the specification at page 6, lines 14-16.

As soon as a set point in the carbon dioxide concentration at the cathode chamber outlet of in the range of from 5 to 40% (v/v) is reached, part of the cooled anode off-gas is withdrawn from the process. This element is discussed in the specification at page 6, lines 14-19 and lines 29 and 30.

Grounds of Rejection to be Reviewed on Appeal

Claims 1-7 and 10-16 were rejected under 35 U.S.C. 103(a) as being unpatentable over Farooque (US 4,917,971) in view of Hildebrandt et al. (US 5,175,061) and further in view of Nakazawa (US 5,134,043).

Argument

Rejection of claims 1-7 and 10-16 under 35 U.S.C. 103(a) as being unpatentable over Farooque in view of Hildebrandt et al. and further in view of Nakazawa.

The claimed invention relates to a process for producing electricity and a concentrated carbon dioxide stream using a Molten Carbonate Fuel Cell (MCFC). In the claimed process cathode

off- gas is cooled, mixed with oxidant and recycled to the cathode chamber inlet. At least part of the anode off-gas is oxidized, with cathode off-gas and/or and external oxidant , and cooled by heat exchange contact with cooled cathode off-gas. At least part of the cooled anode off-gas is fed to the cathode chamber inlet, whereas part of the cooled anode off-gas is removed from the process when a set point in the carbon dioxide concentration at the cathode chamber outlet of in the range of from 5 to 40% (v/v) is reached.

The Farooque reference is directed to a process for producing electricity using at least two MCFCs, wherein part of the anode off-gas of the first MCFC is provided to the anode chamber inlet of the second MCFC and part of cathode off-gas of the second MCFC is provided cathode chamber inlet of the first fuel cell.

As noted by the Examiner in the Office Action, Farooque fails to teach that the oxidant stream comprises at most 20% v/v nitrogen and in addition fails to teach a set point for CO₂ in the cathode off-gas when exiting the cathode chamber outlet.

Contrary, to the observation of the Examiner, Farooque also fails to discloses or teach the element of “bringing the oxidized anode off-gas into heat exchange contact with the remainder of the cooled cathode off-gas to obtain a cooled anode off-gas and a heated mixture of cathode off-gas and external oxidant”. In the Office Action, the Examiner has referred to column 5, line 68 to column 6, line 1 as disclosing this element. Applicants respectfully disagree for the following reason. In the referred section, Farooque refers to the embodiment of Figure 3, wherein a cathode off-gas from cathode chamber (31d) is cooled with air prior to being provided back to cathode chamber (31d). Examiner contends that this anticipates the element of “bringing the oxidized anode off-gas into heat exchange contact with the remainder of the cooled cathode off-gas to obtain a cooled anode off-gas and a heated mixture of cathode off-gas and external oxidant”. Applicants respectfully traverse this observation. In the embodiment of Figure 3 of Farooque, no heat exchange contact between the oxidized anode off-gas and the cooled cathode off-gas is disclosed and therefore no cooled anode off-gas and heated mixture of cathode off-gas and external oxidant can be obtained. Even when applying the teaching of Figure 3 of Farooque to the embodiment of figure 5 of Farooque, no heat exchange contact between the oxidized anode off-gas and the cooled cathode off-gas is disclosed or suggested as the oxidized anode off-gas and cooled cathode off-gas are not present as separate streams after they have been mixed into a

single stream, referred to as oxidant stream (71), where it is noted that teaching of 5, line 68 to column 6, line 1, to which the Examiner refers, is directed at cooling oxidant stream (71).

Farooque also fails to disclose or teach the element “part of the cooled anode off-gas is withdrawn from the process”. The Examiner has omitted to indicate where this element is to be found in the disclosure of Farooque. In the embodiment of Figure 5 of Farooque, part of the anode off-gas, i.e. the hydrogen in the anode off-gas, is recycled to the anode chamber and the remainder is directed to the cathode chamber, after having been catalytically oxidized and mixed with the cathode off-gas. In the embodiments of Farooque, in particular the embodiment depicted in Figure 5, it is part of the cathode off-gas that is withdrawn from MCFC (51), instead of a part of the anode off-gas. For sake of completeness, it is noted that this cathode off-gas withdrawn from MCFC 51 is not withdrawn from the process as required by claim 1 of the present application, but rather provided to a further cathode chamber of a further MCFC fuel cell as depicted in Figure 1.

It is further noted in this respect that Farooque teaches to mix the oxidized anode off-gas (69) and the stream comprising the mixture of cooled cathode off-gas and external oxidant (63) to from oxidant stream (71), as described in Figure 5 and column 5, lines 63 to 65 of Farooque. If the oxidized anode off-gas (69) and the stream comprising the cathode off-gas and external oxidant (63) are mixed it is no longer possible to remove part of the anode off-gas. Let alone, that the reference fails to teach that part of the anode off-gas is to be removed from the process when a set point in the carbon dioxide concentration is reached at the cathode camber outlet of in the range of from 5 to 40% v/v.

Based on the above, it is respectfully submitted that Farooque teaches away from removing part of the cooled anode off-gas, but rather teaches to withdraw part of the cathode off-gas form the process.

In conclusion, it is respectfully submitted that Farooque fails to disclose of teach:

- the element of using an external oxidant comprising at most 20% v/v of nitrogen;
- the element of a set point in the carbon dioxide concentration at the cathode camber outlet of in the range of from 5 to 40% v/v;
- the element of withdrawing part of the cooled anode off-gas from the process;

- the element of withdrawing part of the cooled anode off-gas when the set point has been reached;
- the element of bringing the oxidized anode off-gas into heat exchange contact with the remainder of the cooled cathode off-gas to obtain a cooled anode off-gas and a heated mixture of cathode off-gas and external oxidant.

The Examiner has contested in the Office Action that the element “using an external oxidant comprising at most 20% v/v of nitrogen” is obvious over Farooque in view Hildebrandt. Applicants respectfully traverse this objection. Applicants respectfully submit it would not have been obvious to one of ordinary skill in the art to combine the teachings of the Farooque patent with the teachings of the Hildebrandt patent. The Farooque patent teaches that the fuel cell is operated such that the heat produced by the exothermic electrochemical reaction is the same as the heat required by the endothermic reforming reaction. This allows the fuel cell to be operated without any outside cooling. To achieve this result excess reforming must be conducted which results in excess process gas feed to the fuel cell. The Hildebrandt patent teaches the recycle of the cathode outlet gas to cool the fuel cell. It would not have been obvious to combine the teachings of these two patents because when operating according to the Farooque patent, there would be no need for the additional cooling taught by the Hildebrandt patent. The Nakazawa patent does not add any additional support for this combination.

The Examiner has contested in the Office Action that the element of allowing the carbon dioxide concentration at the cathode chamber outlet to increase until a set point in the carbon dioxide concentration at the cathode chamber outlet of in the range of from 5 to 40% v/v has been reached is obvious over Farooque in view Nakazawa. Applicants respectfully traverse this objection. The mere fact that a single carbon dioxide concentration in the cathode chamber outlet can be calculated based on the numbers mentioned in Nakazawa for the CO₂ inlet concentration to the cathode chamber and the utilization factor does not disclose a process step wherein the carbon dioxide concentration in the cathode chamber outlet is allowed to reach a set point before a further process step, i.e. withdrawing part of the cooled anode-off from the process, is initiated. In the absence of any teaching in Farooque, regarding the withdrawal of part of the cooled anode off-gas, i.e. after heat exchanging the oxidized anode off-gas with the cooled cathode off-gas and external oxidant, from the process, the ordinary person skilled in the art would be provided with

any incentive to calculate the carbon dioxide concentration in the cathode-off gas of Nakazawa, let alone determine a set point in the person carbon dioxide concentration in the cathode-off gas, which in turn would initiate a withdrawal of cooled anode off-gas from the process.

It is noted that, notwithstanding the above, neither Hildebrandt or Nakazawa provide any teaching that would overcome the gap between current claim 1 and the disclosure of Farooque regarding:

- the element of withdrawing part of the cooled anode off-gas from the process;
- the element of withdrawing part of the cooled anode off-gas when the set point has been reached;
- the element of bringing the oxidized anode off-gas into heat exchange contact with the remainder of the cooled cathode off-gas to obtain a cooled anode off-gas and a heated mixture of cathode off-gas and external oxidant.

Inasmuch as claims 1-7 and 10-16 all depend either directly or indirectly from claim 1, Applicants submit that they would not have been obvious for the same reasons.

Conclusion

Based on the foregoing arguments, Applicants assert that the claims of the present application would not have been obvious in view of the cited references. It is respectfully requested that this Appeal be upheld and that the application be sent back to the Examiner for allowance.

Respectfully submitted,

JOZEF PETER PAUL HUIJSMANS et al.

By /Craig M. Lundell/
Their Attorney, Craig M. Lundell
Registration No. 30,284
(713) 241-2475

P. O. Box 2463
Houston, Texas 77252-2463

CLAIMS APPENDIX

1. A process for the generation of electricity and the production of a concentrated carbon dioxide stream using a molten carbonate fuel cell, the fuel cell comprising an electrolyte sandwiched between an anode and a cathode, an anode chamber and a cathode chamber, wherein the process comprises:
 - feeding a fuel gas to the anode chamber and a cathode inlet gas comprising carbon dioxide and a molecular oxygen to the cathode chamber;
 - producing electricity, an anode off-gas and a cathode off-gas via anode and cathode reactions;
 - feeding at least part of the anode off-gas to a catalytic afterburner wherein it is oxidized with an oxidant to obtain an oxidized anode off-gas;
 - recycling the remainder of the anode off-gas to the anode chamber; wherein the oxidant consists of part of the cathode off-gas and/or part of a molecular oxygen containing external oxidant stream, which external oxidant stream comprises at most 20% (v/v) nitrogen;
 - the oxidized anode off-gas is brought into heat-exchange contact with the remainder of the cathode off-gas and the remainder of the external oxidant stream to obtain a cooled anode off-gas and a heated mixture of cathode off-gas and external oxidant;
 - the cathode off-gas is cooled before it is brought in heat-exchange contact with the oxidized anode off-gas;
 - the cooled anode off-gas and the heated mixture of cathode off-gas and external oxidant are fed to the cathode chamber as cathode inlet gas;
 - as soon as a set point in the carbon dioxide concentration at the cathode chamber outlet of in the range of from 5 to 40% (v/v) is reached, part of the cooled anode off-gas is withdrawn from the process.
2. The process of claim 1, wherein the withdrawn anode off-gas is further cooled to separate water from it and to obtain a concentrated carbon dioxide stream.

3. The process of claim 1, wherein the fuel gas is a hydrocarbonaceous gas, and wherein the fuel gas is converted into a carbon monoxide and hydrogen containing gas in the anode chamber.
4. The process of claim 3, wherein only part of the anode off-gas is fed to the catalytic afterburner and the remainder is recycled to the anode chamber.
5. The process of claim 3, wherein the fuel gas is selected from the group consisting of natural gas, methane, biogas, and land-fill gas.
6. The process of claim 1, wherein the fuel gas is a reformer effluent comprising hydrogen and carbon monoxide.
7. The process of claim 1, wherein the fuel gas contain at most 25% (v/v) nitrogen.
8. Canceled
9. Canceled
10. The process of claim 1, wherein 35% to 90% (v/v) of the anode off-gas is recycled to the anode chamber.
11. The process of claim 1, wherein 50% to 80% (v/v) of the anode off-gas is recycled to the anode chamber.
12. The process of claim 1, wherein the fuel gas contains at most 15% (v/v) nitrogen.
13. The process of claim 1, wherein the fuel gas contains at most 10% (v/v) nitrogen.

14. The process of claim 1, wherein the fuel gas contains substantially no nitrogen.
15. The process of claim 1, wherein the set point in carbon dioxide concentration at the cathode chamber outlet is in the range of from 10% to 30% (v/v).
16. The process of claim 1, wherein the external oxidant stream is substantially pure oxygen.

EVIDENCE APPENDIX

None

RELATED PROCEEDINGS APPENDIX

None